

WASTE NOT
Polymer fix for conveyor belts

NEUROSCIENTIST KILEY SEYMOUR UNPACKS CONSCIOUSNESS

PERFORMANCE CAPABILITY NOT LIMITED TO



WESTERN SYDNEY
UNIVERSITY

**RANKED 1ST
IN AUSTRALIA FOR IMPACT**
against the UN's sustainable
development goals



ON THE COVER



➤ Kiley Seymour investigates how the brain manifests consciousness at a physiological level.
page 19

Cover image:
© Cybele Malinowski

WESTERN SYDNEY RESEARCH: TRANSFORMING LIVES AND SHAPING THE FUTURE

Western Sydney University's innovative research empowers communities. Our research improves lives — locally, regionally and globally. In partnership with industry and community, we arrive at research outcomes that are accessible to those who matter most — the users. Our steadfast commitment to quality leads to discoveries that are relevant, applicable and confront real life challenges.

In this third edition of *Future-Makers*, we proudly present stories of Western's research quality and excellence and our important contribution to addressing a wide-range of society's most vexing issues.

The stories of new discoveries and knowledge translation delivered in *Future-Makers* are fascinating and reflect Western's research excellence. More importantly they are stories that are pertinent to the lives of people globally. This publication offers a collection of quality research stories, many of which find solutions to intractable societal problems.

Stories of research success detailing the development of more effective, less invasive treatments for cancer; predicting the effect of climate change on forests; tackling the challenges of future farming and improving farm productivity; investigating the neuroscience underpinning consciousness; and identifying a novel polymer that enables rapid and robust repairs to extend the lifespan of key mining infrastructure collectively reflect Western's exceptional capacity.

We are delighted to share these stories of success and research excellence arising from the extraordinary work of Western Sydney University researchers. ♥

Professor Barney Glover AO
Vice-Chancellor and President

Professor Deborah Sweeney
Deputy Vice-Chancellor and Vice-President
(Research and Innovation)



The UN's Sustainable Development Goals (SDGs) are a blueprint towards a better, more sustainable future (see: sustainabledevelopment.un.org). Western Sydney University has many research projects aligned with these goals. We have indicated relevant SDGs above each article in this issue of *Future-Makers* where applicable.



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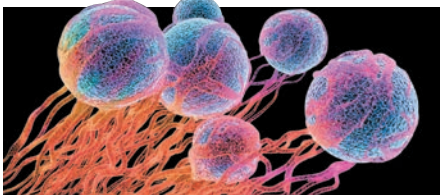
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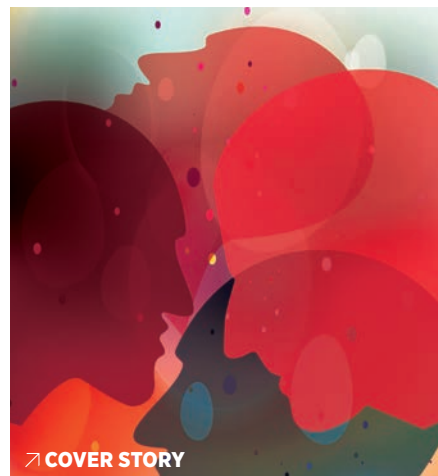
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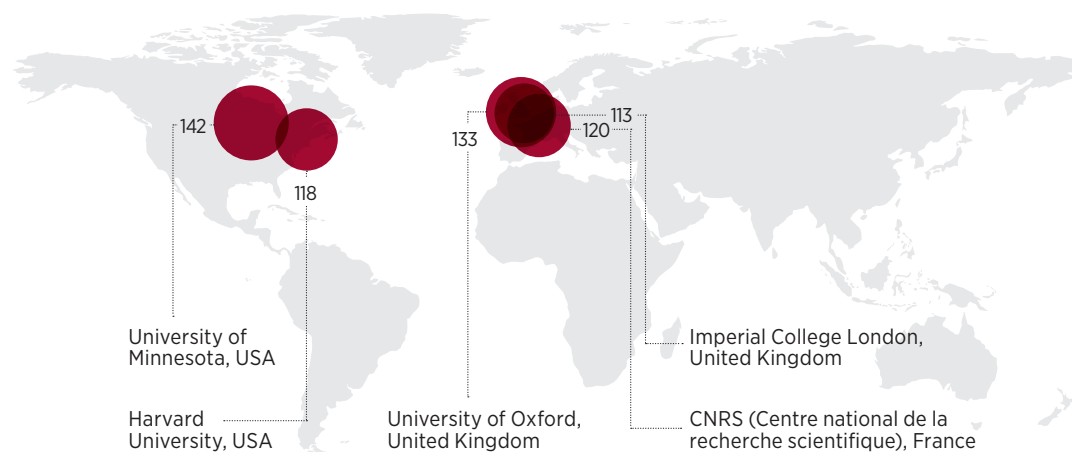
WESTERN SYDNEY UNIVERSITY IN NUMBERS

Located in Greater Western Sydney, one of the fastest growing regions in Australia, Western Sydney University is home to a vibrant and diverse community of staff and students.

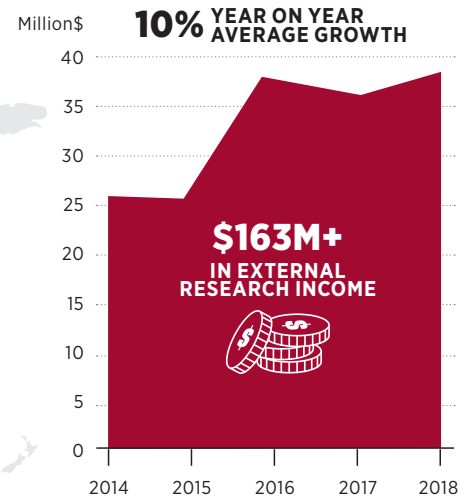
RESEARCH

TOP 5 INTERNATIONAL COLLABORATORS

based on co-authorship for 2014 to 2018 in Scopus-indexed publications ● = Number of co-authored publications

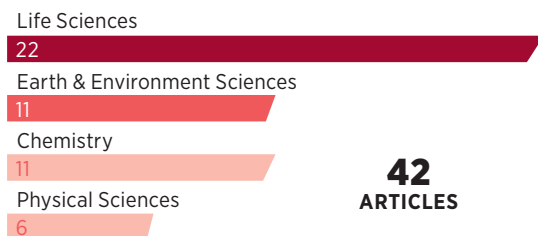


RESEARCH INCOME



RESEARCH OUTPUT BY SUBJECT IN THE NATURE INDEX

(1 February 2018 - 31 January 2019)



* Articles in the Nature Index (www.natureindex.com) may appear in more than one subject category

HIGHER DEGREES COMPLETED IN PAST 5 YEARS

(2014 - 2018)



864 COMPLETED DEGREES

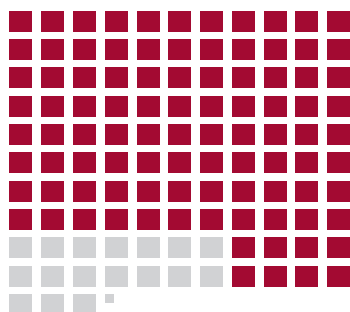
PRODUCE DONATED TO FOODBANK IN 2018 FROM PROTECTED CROPPING RESEARCH



14,660kg

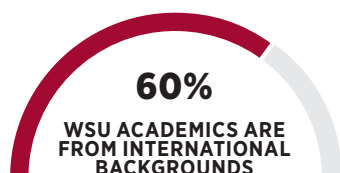
STAFF

ACADEMIC STAFF COMPOSITION ■ = 10 people



1,146 TOTAL STAFF
970 RESEARCH STAFF

GLOBAL PERSPECTIVE



STUDENTS

EDUCATIONAL ATTAINMENT IN FAMILY



48,537 TOTAL STUDENTS
63% FIRST IN FAMILY TO OBTAIN UNIVERSITY DEGREE

ALUMNI

190,000+ GRADUATES
20,000+ WORKING OVERSEAS IN 128 COUNTRIES

GLOBAL RANKINGS

TOP 2%

2020 Times Higher Education World University Rankings



58th
in the THE Young University Rankings

2019 LEIDEN RANKINGS FOR RESEARCH COLLABORATION



80th
in the world

3rd
in Australia



1st in Australia
11th in the world

Ranking for individual sustainability development goals



1st in the world



2nd in the world

ACADEMIC RANKING OF WORLD UNIVERSITIES

41st Ecology
TOP 75 Agricultural Sciences & Civil Engineering
TOP 100 Education



Communication & Media Studies, Nursing, and Sociology

2018 EXCELLENCE IN RESEARCH FOR AUSTRALIA WSU DISCIPLINES ABOVE WORLD STANDARD



- Agricultural and Veterinary Sciences
- Biological Sciences
- Complementary and Alternative Medicine
- Cultural Studies
- Ecological Applications
- Ecology
- Electrical and Electronic Engineering
- Environmental Sciences
- Evolutionary Biology
- Forestry Sciences
- Microbiology
- Nursing
- Oncology and Carcinogenesis
- Pharmacology and Pharmaceutical Sciences
- Plant Biology
- Soil Sciences
- Zoology



- Applied Mathematics
- Biochemistry and Cell Biology
- Communication and Media Studies
- Environmental Science and Management
- Human Geography
- Human Movement and Sports Science
- Language, Communication and Culture
- Linguistics
- Macromolecular and Materials Chemistry
- Materials Engineering
- Mathematical Sciences
- Medical and Health Sciences
- Performing Arts and Creative Writing
- Psychology
- Psychology and Cognitive Sciences
- Pure Mathematics
- Sociology
- Statistics

SDGs: 9

BELT WITH BRACES

A novel polymer provides rapid and robust repairs to extend the lifespan of key mining infrastructure.

The vast scale of mining sites can be hard to comprehend. Everything is oversized, from the mine itself, which can rival the magnitude of Sydney Harbour, to tip trucks rumbling across it on wheels as tall as a human, and ore-carrying conveyor belts that can be tens of kilometres long.

When one of these conveyor belts gets damaged by the rough ore it is carrying, throwing away such a large piece of rubber is not economically or environmentally optimal. If the belts were repaired, traditionally, a two-part product that had to be mixed just prior to application was used. But this product was time-consuming to apply, and as

the conveyor belt is subject to a lot of force, it often only provided a temporary fix.

An innovative research team at Western Sydney University has helped develop a one-part polymer resin product called RubbaFix™ that can quickly and effectively fix the damage. Not only does this avoid replacing a vast length of serviceable rubber belt; the repair product itself is bio-sourced from waste such as vegetable cooking oil, making it an environmentally friendly product, according to Dr Patrice Castignolles, a polymer chemist at Western's School of Science and Health.

The project began in 2013, when Imatech, a Sydney-based industrial solutions company, approached Dr Richard Wuhler, Research Manager of Western's Advanced Materials Characterisation Facility, to test certain properties of RubbaFix™. Wuhler soon brought Castignolles and fellow polymer chemist, Dr Marion Gaborieau, into the conversation.

Castignolles and Gaborieau had previously worked together as part of a team, making and assessing the chemical characteristics of polymers for controlled release delivery systems for anticancer drugs, among other projects. They brought the same skills to the rubber repair product.

THE MINING SECTOR
contributed
more than



=\$10 billion
**\$35
BILLION**
to Australia's GDP
in 2018.

The project quickly expanded from testing specific aspects of the new product's properties to actually helping to develop certain additives for it. The Western team was charged with finding additives to make the repair resin a uniform black colour, and to ensure it had the correct electrical resistivity. "The moving belt creates a lot of electrostatic friction that builds up electricity," says Castignolles. The effect is like an extreme version of rubbing a balloon against woollen fabric. "You could have an electrical discharge if you are not conducting the charge well enough," he adds, which has potential to trigger an explosion in the mine.

The additive the team selected to make the product black showed excellent chemical compatibility with the resin and dispersed homogeneously through it.

NEED TO KNOW

- Large conveyor belts used in mining sites often become damaged due to their rough cargo.
- Western researchers, in partnership with Imatech, are developing a polymer to fix them.
- This work could lead to significant environmental and cost savings.

A conveyor belt in action.

© Russell Eggers, Imatech; © ONYXpr/istock/Getty; © Sally Tsoutas
This research was supported by a Warwick J. Rule PhD scholarship from Imatech Pty Ltd., and research funding from the Australian Government Research Training Program (RTP).

Moreover, when mixed in the right proportion, the additive also gave the resin the desired electrical resistivity. “Using one additive instead of two is obviously good for cutting down the cost and complexity of manufacturing,” Castignolles says.

**“MINING IS
CARRIED OUT
FROM THE
DEPTHS OF
THE CANADIAN
WINTER, TO THE
SAUDI ARABIAN
SUMMER.”**

In most environmental conditions, the product the partners developed, offers a permanent damage repair. The next step — and the subject of an ongoing PhD project funded by Imatech — is to cover all conditions. “Mining is carried out from the depths of the Canadian winter, to the Saudi Arabian summer,” explains Russell Eggers, Imatech’s CEO. “The work we are doing is to give us positive product attributes at the extremes

of temperature and humidity, as well as in the middle of the range,” he says.

The company’s ultimate aim is to be able to dial up the ideal formulation and produce bespoke products for any environmental conditions, Eggers says. In the interim, a range of off-the-shelf products for different conditions is planned. “We could not do this without the University,” Eggers says. “One of the big benefits of the relationship is that we get access to state-of-the-art capabilities. As a small company we don’t have the capacity to achieve that in any other way,” he says.

The benefits flow both ways, Castignolles says. “This project is an opportunity for us to teach students what is required to work with industry,” he says. “That is not really something you can do in a lecture.” In addition to the PhD project, Masters students and undergraduates have also been involved, helping test the resin’s resilience in acidic, alkaline and other potentially corrosive conditions.

“It’s a valuable mutually beneficial relationship,” Eggers concludes. “I personally enjoy working with the University and look forward to commercialising the end-user benefits we are jointly targeting.”

(left to right) Patrice Castignolles,
Marion Gaborieau and Richard Wuhrer.



SDGs: 13 15

SOWING SEEDS FOR THE FUTURE OF FORESTS

Paul Rymer is peering into the spaces between genes to learn how to help forests survive climate change.

If Australia's forests

are to survive climate change, we need to find a smarter way to manage them, says Dr Paul Rymer, a senior lecturer at Western's Hawkesbury Institute for the Environment.

A common assumption in climate change modelling is that forests are populations of genetically identical trees. But Rymer's work is demonstrating for the first time that a forest in fact is made up of individuals, some of which cope with heat and dry better than others.

Rymer is searching for genetic features that contribute to trees' adaptation to climate change,

NEED TO KNOW

- Interventions are needed if Australian forests are to survive the effects of climate change.
- Sections of a plant's genome determine how it responds to drought conditions.
- Choosing plants with an appropriate genetic make-up is essential for future forest planning.

so that they can be taken into account for forest management.

"Plants have very large genomes with lots of spaces around the genes. Originally we thought the spaces didn't tell us anything about the gene, but those components are actually important for the regulation of the gene and how they are coordinated," says Rymer. His work tracks down the sections of the plant genome that allow it to switch on or off the genes associated with survival in adverse climate conditions.

Rainfall in south Western Australia has decreased by 20% over the last 30 years and is expected to become more scarce as the climate changes. Unlike animals, however, forests cannot uproot and migrate to more temperate regions. The towering jarrah forests of Western Australia, for example, have already experienced significant die-off.

Rymer and collaborators recently sequenced the DNA of 270 Western Australian marri

trees (*Corymbia calophylla*) growing in different temperatures and rainfall microclimates. The team found 537 changes in the DNA linked with different climates. Such large genetic variation shows that the species may be well equipped to weather a changing climate.

Dr Margaret Byrne, who worked with Rymer on the marri tree DNA sequencing project is the director of the Science and Conservation Division at the Western Australian Department of Parks and Wildlife. She believes their collaborative work will help the department understand how to effectively manage vulnerable forests.

Rymer says they plan to put the results to use by planting seeds known to have a good genetic make-up, or selecting species, such as the marri, that will cope with variable climate conditions. "We need to make sure we're choosing the right genetic material for the future," he explains. ■



Jarrah forests have experienced die-off due to climate change.

This research was supported by the Australian Government through the Australian Research Council.

SDGs: 2 12 15

MICROBES AT THE ROOT OF SUSTAINABLE FARMING

The millions of microbes living on plants could help ensure the future of farming.

Researchers in Western Sydney are unearthing the critical links between bacteria and plants that could make farming more sustainable.

Plant roots, stems, leaves, flowers and seeds are home to millions of microbes that increase a plant's nutrient uptake and protect them against pests and diseases. "Plants and microbes have evolved together for millennia," says Professor Brajesh Singh, from Western Sydney University's Hawkesbury Institute for the Environment. "A plant's fitness is closely aligned with its microbiome," he adds.

Singh is developing microbial engineering tools that could sustainably increase agricultural output to produce food for a rapidly increasing population. Food productivity needs to be raised by 70%, in the face of diminishing allocation of land for agriculture.

Farmers have long used pesticide spray or 'seed dressing', in which seeds are coated in pesticides or fungicides to protect them during germination, but these introduce harmful chemicals to the ecosystem. Instead, Singh and his colleagues are using microbial and biochemical technology to manipulate plant and soil microbiomes to create natural microbial

NEED TO KNOW

- Western researchers are using microbial and biochemical technologies to manipulate crop microbiomes.
- These microbial technologies will help crops grow under stressful situations.
- Some of these microbes increased the productivity of wheat, lettuce and cotton by 35 to 100%.



Many microbes are found in a plant's root system.



Brajesh Singh is trying to make farming more sustainable.

communities that help crops grow under stressful conditions such as drought, disease and nutrient deficiencies by promoting more efficient use of resources, and boosting resilience to pests. This will strengthen crops and enhance agricultural production in hostile climates and restore land damaged by the excessive use of chemical fertilisers. "Microbiomes are one of the fastest growing sectors in agriculture," says Singh. "They could eventually be worth as much as the current chemical pesticide market."

Singh's team has been working with Converte, an Australian plantfood company

that designs products for improving soil health. Managing director, John Ridley, says "This pioneering work on microbiomes is transforming soil and plant systems in ways that could significantly improve food and climate security".

There is much to be done before the benefits will be realised on the land. "We have developed some microbial products that increase the productivity of wheat, lettuce and cotton by 35 to 100%," says Singh. "But these experiments have mostly been in greenhouses. This is fine for lettuce, but for wheat and cotton, we need to test the products in the field to see if we can replicate this success." ■



SDGs: 13 15

FOOD FOR THOUGHT

Farmers who take stock of what works on their land, rather than forcing crops upon it, could improve productivity.



Paying attention to the historical use of the land can help reduce degradation.

NEED TO KNOW

- Land degradation is threatening the future of food production.
- Focussing on maximum productivity could prove fatal to farming.
- Letting nature back in could help create healthier ecosystems.

A cattle farmer scouring records of his property before Australia was colonised found descriptions of swamplands and natural creeks that disappeared because farming practices channelled the water away. Deciding to let nature take its course, Peter Andrews removed obstacles to these sources and now water flows slowly across the land, meaning the soil can retain it for longer.

Inspirational stories such as these are being gathered and shared by Western Sydney University researcher, Dr Gerda Roelvink, who wants to learn about Australian farmers who have made big changes to their farming practices and broken away from intensive agriculture.

Learning to look at the land in new ways could help the country's farmers restore damaged ecosystems and ensure agricultural productivity for years to come, according to Roelvink.

Many farmers fixate on maximising production of a single crop on a vast scale, regardless of natural soil and environmental conditions. But

as climatic conditions become less conducive, cracks begin to appear in this intensive approach, just as they appear across the parched farmland. Around the world, pockets of alternative agricultural practices are emerging that could improve our use of the land and even restore lost habitats. But convincing traditional farmers to change their farming patterns is difficult.

Roelvink, from Western's School of Social Sciences and Psychology, works with the Community Economies Collective (CEC), an international research group that aims to reframe how we think about the economy, placing a greater emphasis on ethics and responsiveness to environmental issues. "Environmental degradation is one of our most pressing challenges," she says, "so I've been exploring our consideration of the environment, and other species, as we create ethical economic alternatives." Roelvink suggests that societies growing more sensitive to the non-human world around them, could help change attitudes to agriculture, a notion first described by the anthropologist Bruno Latour.

Roelvink's interest in farmers' approaches revealed varied outcomes. "I was really interested in what sparked these changes," she says, "what it takes for a farmer to change in response to these incredible environmental challenges, and why they don't just leave the land or try out new fertilisers or farming technologies."

Most of the farmers she spoke to, it seemed, had experienced a revelation while surveying their land that

led them to reconsider their relationship with it.

For John Weatherstone, a livestock farmer, the revelation came while photographing his farmland at Lyndfield Park, south-west of Sydney, after a particularly severe drought. He noticed that weeds were thriving in the neglected borders of the land, untouched by chemicals and fertilisers, explains Roelvink, "while, before his eyes, the topsoil on the rest of his farm blew away

in the winds". Weatherstone saw an opportunity for change. He reduced sheep numbers, planted and began producing seeds of local trees and shrubs, such as acacia and eucalyptus, for wholesale, eventually transforming the land into a lush oasis amidst monocultures on neighbouring farms. The highlight for Weatherstone was seeing native birds return to his land.

Associate Professor Jenny Cameron at the University

of Newcastle, inspired by Roelvink's findings, used the same approach in her research on community gardens, demonstrating how it applies at different scales. Cameron found that, by learning to be affected like Roelvink's observant farmers, "community gardeners were becoming sensitised to environmental changes in the world around them as they went about caring for plants, seedlings, compost, soil and insects".

"WE NEED FARMERS TO RECOGNISE THAT THEY ARE ALSO CUSTODIANS OF THE LAND."

The challenge now lies in connecting these isolated scenarios and ensuring new approaches are recognised as credible alternatives to traditional farming, for example by enlisting the support of the Wentworth Group of Concerned Scientists. Roelvink and her colleagues also gather at international conferences and local meetings to discuss the progress of current projects, and the CEC shares its work proudly online and at public events. "We hope that by making these stories more publicly known, we can inspire other farmers to break away from intensive approaches" says Roelvink. "There's an expectation on farmers to feed the world, but we need them to recognise that they are also custodians of the land." ♥



Gerda Roelvink is collecting stories from farmers who are reconsidering their relationship with the land.

SDGs: **13** **15**

SEEING THE FOREST THROUGH THE TREES

An accurate model of leaf transpiration will make it easier to predict the effect of climate change on forests.

How do you mathematically

model a tree? It might seem like an odd question, but it is a fundamental challenge facing scientists trying to find out how the environment will respond to a changing climate.

At Western Sydney University's Hawkesbury Institute for the Environment, ARC Laureate Fellow, Professor Belinda Medlyn and colleagues have been developing models of forests that can be used to predict how they will be affected by changes in

temperature, rainfall and carbon dioxide, and how they will also affect the climate around them.

"We know the climate has already started to change, and that will have a significant impact on the vegetation across the world, but these climate-driven changes are really hard to predict because there are so many different pieces to the puzzle," says Medlyn.

One of those pieces is the question of how much water has transpired, or evaporated, from leaves. For the past few decades, modellers have assumed that the

rate of transpiration was essentially the same across all different types of vegetation. But Medlyn took a closer look at the real-world data on water vapour transpiration from leaves, and realised something wasn't right. So she built a new model of leaf transpiration, which accurately predicts transpiration regardless of species.

Research collaborator, Martin De Kauwe, research fellow at the Climate Change Research Centre at the University of New South Wales, says Medlyn's model was a significant step forward, and is now incorporated into all major models of forest responses. It has also had major implications for understanding how forests respond to extreme climate events such as heat waves, he adds.

"We were able to show from the measurements and her model that evergreen needle-leaf forests

have a more conservative water use behaviour, and that basically changes the feedback of water into the atmosphere," he explains. The revised model, incorporating

NEED TO KNOW

- Belinda Medlyn has developed a transpiration model that works across all plant species.
- It is now incorporated into all major models of forest behaviour.
- This work will help researchers understand how forests respond to extreme climate events.



Tarra-Bulga National Park in South Gippsland, Victoria.

Medlyn's work, suggests that instead of releasing water into the atmosphere during heat waves, which would lower temperatures, these forests hold on to their water, which could actually make heat waves worse. This means previous models may have underestimated the heat wave intensity across northern Europe, explains De Kauwe.

Modelling these processes requires a unique combination of skills – mathematics and ecology. Medlyn had always loved mathematics, but after starting her professional career working in a bank, realised she wanted to apply it to the natural world. “There’s a huge need for people with mathematical skills to work in areas like climate science and ecological modelling,” she says.

The transpiration model is just one piece of the puzzle: Medlyn's overall aim is to develop models that describe forests, particularly Australian ones, and predict how they are responding to climate change, by piecing together as much evidence as possible. That includes modelling the response of forests and trees to increasing carbon dioxide, more frequent and severe drought, and of course, increasing and more severe heatwaves.

It’s a huge task, and despite the years of research already undertaken with her colleagues, Medlyn says in some ways they’re just at the beginning of the process. “I can talk to you about what happens to each of those elements, separately, but putting them together is the tricky part.”



This research was supported by the Australian Government through the Australian Research Council.
© Southern Lightscapes-Australia/Moment/Getty Images



SDGs: **9** **11**

EYE IN THE SKY KEEPS BRIDGES SAFE

Faster, cheaper, and safer bridge inspections through drones.

Drones can take up

some of the burden of inspecting Australia's 50,000 bridges, research from Western Sydney University has shown. Bridge management researcher, Dr Maria Rashidi from the Centre for Infrastructure Engineering and her team have partnered with Roads and Maritime Services New South Wales to test drone technology for visual bridge inspections. They have shown that drones can be faster, cheaper, safer, and more reliable than manual inspections.

Rashidi has focussed on bridge management since her PhD and she says caring for this essential element of transport infrastructure is a big task. “More than 80% of Australia's bridges were built before 1976, and require routine visual inspection every two years to ascertain proper performance,” Rashidi says.

To see if drones could help, the team used a professional-specification drone with triple-redundancy safety systems for battery and rotors to capture images of four bridges from multiple angles. For large bridges, drones were generally faster and cheaper than conventional inspection, the pilot study showed.

The results have encouraged Roads and Maritime Services New South Wales engineer, Houman Hatamian. “Drones are

NEED TO KNOW

- There are 50,000 bridges in Australia.
- Each bridge must be visually assessed every two years.
- Drone bridge visual inspections are generally faster and cheaper within the limits of the technology.

particularly useful in cases where access puts bridge inspectors at risk, or conventional access methods are prohibitively costly, or require traffic control that may affect commuters,” he says.

Rashidi, Hatamian, and the team are now collaborating on the second phase of the research project, testing artificial intelligence and machine learning approaches to enhance the accuracy of data collected.

“Since the first pilot project, we have been approached by different agencies and transportation authorities for drone projects,” Rashidi says. The team also recently began using their expertise to help with the conservation of heritage bridges, she adds.

SDGs: 13 15

ANSWERING BURNING QUESTIONS

A smarter, systematic approach to controlled burning will help ensure resources go where they're needed most.

Every year, bushfires blaze across Australia and leave destruction in their wake. But thanks to a new tool developed by a consortium of Bushfire and Natural Hazards CRC researchers from Western Sydney University, the University of Wollongong and the University of Melbourne, fire risk in the future may be much easier to predict. The team's 'Prescribed Burning Atlas' is the most detailed look yet at the effectiveness of prescribed

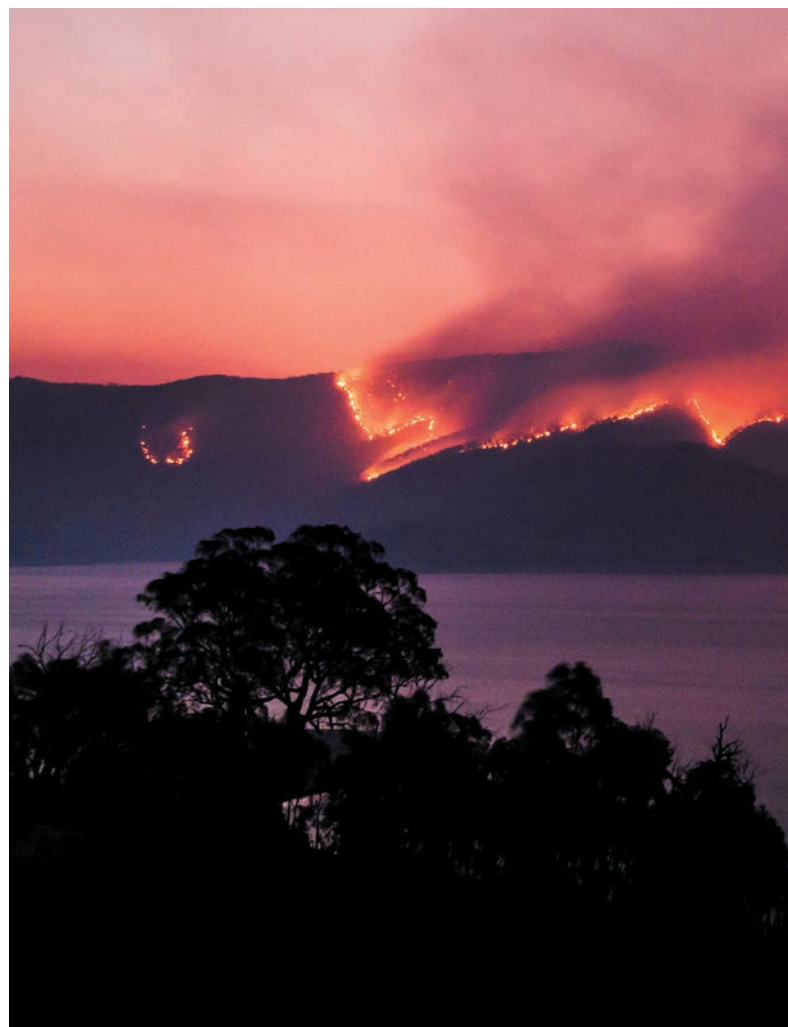
burning for mitigating bushfire risk in Australia.

Australian fire services carry out controlled or 'prescribed' burns in low fire risk months to reduce the amount of fuel built up in bushland. Currently, fire agencies plan these burns years in advance, assessing a range of factors including land use, population density, vegetation and weather conditions. But until now, says Western Sydney's Associate Professor Matthias Boer, the effectiveness of prescribed burning in preventing wildfire has been presumed, rather than studied.

"It's expensive to deploy resources for controlled burning, while the effectiveness in terms of risk reduction is still relatively poorly quantified," says Boer.

"This project will allow agencies to take more informed decisions about how their management dollar can go furthest."

With Dr Hamish Clarke, who holds a joint appointment as a Research Fellow at Western Sydney University and the University of Wollongong, along with Associate Professor Trent Penman, and Brett Cirulis at the University of Melbourne, Dr



Owen Price and project leader Professor Ross Bradstock at the University of Wollongong, Boer is developing a computer tool that maps where prescribed burning may be most effective.

The core of the project is a series of fire simulations in 13 case study landscapes across southern Australia, ranging from cities to rural areas, forests to grasslands, and native to modified vegetation.

For each case study, Clarke and the team run up to 100,000 simulations covering different weather scenarios, prescribed burning treatment rates and treatment locations (such as

near homes versus treating more remote areas).

"The end result is thousands of simulated wildfires, which vary in size, intensity and impact, depending on all these factors. It's our job to make sense of all of this," explains Clarke.

The team has been able to produce risk estimates for a range of different outcomes, for instance how many houses would be lost in different conditions, or how effective prescribed burning would be in different areas.

The project is also looking at how climate change may affect prescribed burning, by simulating intensified hot and

NEED TO KNOW

- Prescribed burning is thought to reduce the risk of a bushfire spreading.
- A computer tool is modelling the effects of prescribed burns.
- The tool is based on 13 case study landscapes across southern Australia.

© Robyn Macrae / EyeEm/Getty Images



dry, high-wind weather conditions that are projected in some areas.

The team is working with potential users of the Prescribed Burning Atlas, including major fire management agencies across Australia, and is planning to complete a prototype ready for testing in late 2019, with a national launch scheduled for 2020. End users are enthusiastic about the type of information the atlas will provide.

“The ability to quantify risk to life and property has the potential to help

land managers to optimise burning strategies to achieve the best cost-benefits,” says Dr Felipe Aires, Fire Science Interpretation Officer at the NSW National Parks and Wildlife Service. “Ultimately, we hope that the atlas will help fire managers tailor decisions about burning programmes to optimise risk reduction.”

The atlas is the first example of a fire risk reduction project being attempted on a nation-wide scale, says Boer, and the team’s approach could even be used to build similar

tools overseas, including in the Mediterranean and the United States.

In Australia, one of the most catastrophic bushfire events was Black Saturday, which claimed the lives of 173 people. The 2009 Victorian Bushfires Royal Commission which followed recommended a 5% annual prescribed burning target of the state’s public land. “Now we have a tool to objectively assess how much risk reduction can be achieved under this or other targets across the diversity of the Australian landscapes” says Boer. ■

**BETWEEN
1967 AND 2013,
MAJOR AUSTRALIAN
BUSHFIRES
HAVE RESULTED IN**

**OVER
8,000
INJURIES**

**433
FATALITIES**



**CLOSE TO 50%
OF ALL DEATHS**
from major Australian
natural disasters
(excluding heatwaves)



**COSTS OF ROUGHLY
A\$4.7
BILLION**

(Including deaths and injuries but
excluding most indirect losses,
in 2013 Australian dollars.)

● =100 injuries; + =100 fatalities; ■ =A\$1 billion

SDGs: **2** **15**

PLAN BEE

In making plans to withstand a globally devastating bee parasite, researchers are finding other ways to help crops thrive.

Australia is the final stronghold against the Varroa mite (*Varroa destructor*). This microscopic parasite has sucked the life out of honey bee hives the world over, prompting headlines urging action, and global pro-bee campaigns. In addition to making honey, bees pollinate crops, and plants such as clover that add nutrients to pasture.

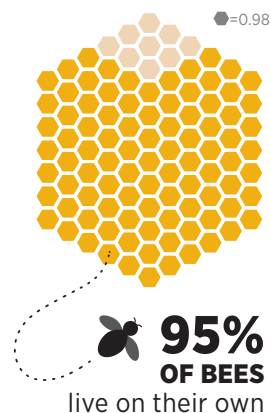
While Australia is still Varroa-free, it has been intercepted twice in the last five years coming in on ships. “Pretty much everyone thinks it’s a case of when we get it, not if we get it,” says Professor James Cook, leader of the Plants, Animals and Interactions research theme at Western’s Hawkesbury Institute for the Environment. He is leading a five-year, \$19 million research push to better understand

bees’ role in crop pollination, so that when Varroa arrives, Australia is prepared to minimise the damage.

“We expect a rapid drop-off in honey bee colonies and that’s what we need to be ready for. But the good news is Varroa is really specific to honey bees so it’s not going to affect stingless bees, or our many species of solitary bees,” says Cook.

Contrary to popular understanding, European honey bees (*Apis mellifera*) are the exception when it comes to bees. Of the world’s 20,000 species of bees, only seven species live in large colonies, have stingers, and make honey. Around 95% of bees live on their own. There are also about 500 species of stingless bees, which also live in colonies, but most don’t make enough honey for humans to harvest. Many of these lesser-known bees, along with some other insects, such as flies, are consummate pollinators, and they could be the insurance policy Australian farmers are looking for. But much needs to be learned before

BUZZ OFF AND LEAVE ME ALONE



STING LIKE A BEE?

There are **500 SPECIES** of stingless bees

their role as a safeguard against honey bee losses can be assured.

This multi-pronged project is funded by a partnership initiative developed by Hort Innovation, with co-investment from Bayer CropScience, Syngenta Asia-Pacific, the food and agri-business company, OLAM, and Greening Australia, along with contributions from the Australian Government.

Ashley Zamek is the manager of the programme at Hort Innovation. She says the research is about protecting pollination. “We have 35 member organisations at Hort Innovation and 25 of them depend on pollination. We don’t want to put all our eggs in one basket so we’re exploring stingless bees, flies, and honeybees and the pollination services they provide.

“WSU proved to

be the best at delivering this type of research. Their state-of-the-art facilities including greenhouses and polytunnels meant they have the infrastructure to work with us.”

Of the many avenues Professor Cook is exploring, one is deploying stingless bees into glasshouses containing commercial crops. In this regard, they may be superior to the honey bee.

“Honey bees don’t like being in glasshouses and polytunnels and they sting people who are working there. So, having a stingless bee is good from that point of view,” says Cook.

His team have moved hives of *Tetragonula carbonaria*, a small black Australian stingless bee commonly known as the sugarbag bee, into glasshouses to see how the bees coped. They weighed the bees before and after they were put in the greenhouse, took note of honey and pollen stocks in the hive, and monitored their behaviour for any unusual signs.

They found that many bees spent the first two weeks pressed up against the glass trying to get to their usual feeding fields, but then the colonies settled down and began to enjoy the blossom banquet before them.

Kayla Le Gros is a masters student working on the bee project. She looked specifically at whether the native bees can navigate successfully in glasshouses, and whether a UV-blocking film on the glass affected the bees. Honeybees navigate using the ultraviolet end of the light spectrum, but it was not known whether *T. carbonaria* bees also do.

“With the native bees we found there was absolutely no difference between the two claddings, so that meant they were using colour

NEED TO KNOW

- Australian stingless bees are being tested as crop pollinators.
- Stingless bees are not affected by the devastating Varroa mite.
- Stingless bee knowledge could be exported to help farmers globally.



vision or landmarks to find their way to and from the hive,” says Le Gros. With or without the film, the bees found their way around the glasshouse with no trouble.

Her finding is a sweetener for the case for stingless bees, as UV-blocking glass is preferred by horticulturalists.

Now other members of Cook’s team are looking at finer details such as whether the stingless bees do better with pollen, sugar or floral supplements to their diets and examining their adequacy as pollinators for specific crops.

The first test is with strawberries, usually grown in long polytunnels. Individual strawberry plants are covered with a small muslin bag to prevent accidental pollination, then uncovered to let the bees in. Researchers observe bees visiting and then re-bag the plant after a flower has had one, two, or three visits. They then monitor the plants and record the number of fruits produced, and their quality, correlating this with the number of bee visits.

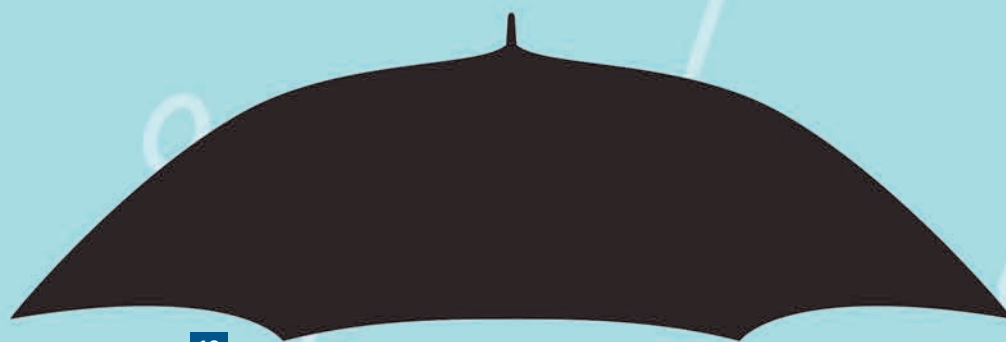
The lessons learned on Australian stingless bees could very easily be applied to stingless bees native to other locations around the world; Indonesia, Malaysia, India and Thailand have very closely related stingless bees and are also keen to make more use of them. Cook expects there will be transfer of methods, equipment and knowledge between countries.

With insect species around the world threatened by pesticide use, loss of habitat and growing urbanisation, a deeper understanding of the unseen hand of the pollinators is essential for our own species. As Cook puts it: “Our fate is very intertwined with that of pollinators.” ♥

“OUR FATE
IS VERY
INTERTWINED
WITH
THAT OF
POLLINATORS.”

Stingless bees, such as *Tetragonula carbonaria* are not susceptible to the Varroa mite.



SDGs: **16**

PROTECTING ANONYMITY

Researchers search for ways to safeguard the data of study participants.

NEED TO KNOW

- Universities need to safeguard sensitive information derived from research participants.
- The San-Shi system allows analysis to be conducted on encrypted data on an aggregate level.
- This preserves data privacy and security.

As the social sciences move into the realm of big data, researchers need to rethink their data handling practices to ensure the privacy and security of study participants, says Dr Liam Magee, a senior research fellow at Western's Institute for Culture and Society.

Magee and colleagues are working on a hybrid social computing project, investigating techniques that will allow social science researchers to analyse unprecedented levels of

experimental data in a secure and ethical way.

The techniques being examined by the team, and their applications in the social sciences, are distinctive because of the way data can be encrypted, and used in its encrypted form, explains Magee.

Universities go to great lengths to protect the data they hold for research purposes. This can include anonymising datasets before storing and processing information.

Despite their effort, hackers can employ machine-learning algorithms to identify participants from stored information about age, background and education. "It's not a theoretical threat," says Magee. "This has happened."

One possible solution, he says, is a database system that embeds the necessary security features from the start. The San-Shi computing system, designed by Japanese telecommunications company, NTT, fits the bill. "It's

one of a relatively new breed of systems that is looking at ways analysis can be conducted while the data is still encrypted,” he explains.

“THE INDIVIDUAL REMAINS OBSCURED BY THE SYSTEM AS A PART OF ITS DESIGN.”

San-Shi breaks each participant’s dataset apart, encrypting the chunks of information separately and storing them across multiple computer servers. Data about a person’s age, for instance, is split into separate fragments, none of which are meaningful in their own right. The platform can carry out an analysis on the whole dataset by combining information shared from each of the servers. But crucially, if any one server is hacked, only a meaningless part of any person’s dataset will be revealed. “The hacker won’t be able to make any sense of the partial information,” says Magee.

While this security technique is widely known in the information technology industry, it has only recently been able to handle

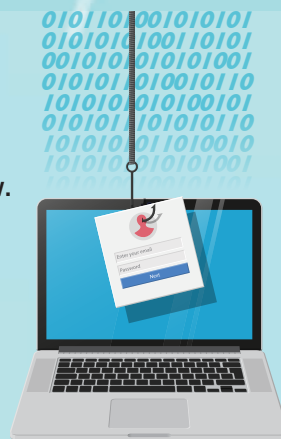
large datasets. As a result, it has not been widely used with social research datasets, says Magee. But its promise is significant: “At no point can the researcher gain access to an individual record in a system of this sort, it only ever provides data at an aggregate level,” explains Magee, “so the individual remains for all intents and purposes obscured by the system as a part of its design.”

Magee’s team at Western is collaborating with Dimension Data, an NTT subsidiary, to test how this system will work in social science research applications. To do this, Magee and his colleagues developed code to create synthetic or proxy datasets — similar to what would be gathered in real-life health or education surveys, to ensure the experiments are realistic — and to analyse them within San-Shi’s encrypted environment.

In one experiment, Magee and the team posited a case

DATA BREACHES
must be disclosed
to the Office of the
Australian Information
Commissioner under law.

812
DATA
BREACHES
were reported
in 2018.



where researchers wanted to link demographic information with student attitudes regarding course relevance to work-readiness. The team uploaded survey responses that included student identification numbers on to the San-Shi system, and separately added a copy of student enrolment records with demographic information, where both were

encrypted. In this fictional scenario, they were then able to obtain useful statistical information based on the aggregate data without being able to identify sensitive information from specific students.

Over the next year, the team will process actual research data. Magee is optimistic about the opportunities. “Ultimately, we could imagine live data being fed into this system, being used for research purposes and providing researchers with the kind of results they need, without revealing records at the individual level.”

Magee warns that such technical security safeguards are only part of a much wider reappraisal of data ethics and governance. The challenges posed by big data, AI and cloud computing require a continued focus on the controls and consent users can exercise over their data. ■

Liam Magee is helping to keep social science research participants’ data safe.



SDGs: **3**

PEERING INTO THE MIND'S EYE

A Western Sydney University researcher is investigating the neuroscience underpinning consciousness.

“Fundamentally I’m interested in how the brain works,”

says Western Sydney University psychologist, Kiley Seymour. “The question I’m investigating now is how the brain manifests consciousness at a physiological level.”

Seymour’s work in this simultaneously philosophical and scientific arena could address long-standing questions around the neurological underpinnings of schizophrenia, and could also have implications for how neuroscience is used as evidence in the courtroom.

THE BINDING PROBLEM

Seymour’s curiosity about the workings of the brain was piqued during her undergraduate studies in biology about the physiology of memory and learning. After working in molecular biology and genetics for a few years as a research assistant, she completed a masters in neuroscience at the Max Planck Institute in Germany.

That led to her PhD at the University of Sydney, which explored one of the big mysteries in neuroscience, known as the ‘binding

problem’. The binding problem asks how the brain allows us to see the world as a coherent whole when different visual features such as colour, motion, and form are processed in largely segregated brain regions and visual pathways.

“What we know so far about brain processing is that different aspects of a visual image, colour, motion and depth, for example, are processed in separate parts of the brain,” she says. “Yet somehow, our brain effortlessly integrates this



NEED TO KNOW

- The binding problem asks how the brain perceives visual sensory data as a cohesive picture.
- People with schizophrenia have trouble processing visual sensory data.
- Advanced imaging technology could shed light on this problem.

information so that we see the world in a very coherent way — the question is how?”

To find the answer, she combined the latest in magnetic resonance imaging (MRI) technology and machine learning algorithms from the field of artificial intelligence to look for parts of the brain that were sensitive to different conjunctions of colour and motion.

Volunteers were put in an MRI scanner and shown displays consisting of red dots moving left and overlapping with green dots moving right, or green dots moving left paired with red dots moving right. By observing data from their brain, Seymour and her colleagues were able to tell which of these two combinations of colour and motion the subject is actually looking at. “If an area of the brain can discriminate between the two combinations of colour and motion, then it implies that this area contains neurons sensitive to the conjunction of these features” she says.

From that deceptively simple experimental structure, Seymour was able to overturn previous dogma on the binding problem, and show that instead of colour and motion being processed in separate ‘modules’ in the brain and then combined at a later stage, these features are conjointly represented (bound) very early in the brain’s visual system.

The finding made sense, Seymour says. “Why would the brain segment everything and then bring it back together at a later stage? That operation seems redundant.”

“BEING ABLE TO LOOK AT THE BRAIN ON THAT SCALE, WHILE PEOPLE ARE DOING PARTICULAR TASKS, IS A REAL ADVANCE FOR HUMAN NEUROSCIENCE”

Seymour’s PhD supervisor and long-time mentor, Professor Colin Clifford, from the School of Psychology at UNSW Sydney, says Seymour’s work focuses on a fundamental, basic science question. “We need to understand how the normally-functioning brain works before we can treat deficits or damage to an injured brain,” he says.

ALTERED PERCEPTION IN SCHIZOPHRENIA

Dr Seymour’s research at Western’s School of Social Sciences and Psychology, the MARCS Institute for Brain, Behaviour



and Development, and the Translational Health Research Institute, could shed light on what is going on in the brains of people with schizophrenia. One idea suggests that schizophrenia is the result of a problem in processing sensory information, which might lead to the experience of hallucinations and distorted beliefs or delusions.

“I want to try and understand what’s happening in the brain when patients hallucinate or hold delusional beliefs about the world, for instance the belief that they’re being controlled by another agent,” says Seymour.

To do this, she is working with a cohort of volunteers with

schizophrenia who undergo MRI scanning while viewing simple visual stimuli. Seymour is hoping she’ll be able to spot issues with the way sensory information is processed during these tests.

Her work has already generated some interesting results. In a paper published in *Neuropsychopharmacology*, Seymour and colleagues reported that the brains of people with schizophrenia have problems processing visual sensory data, and that the hallucinations that form part of the illness may represent the brain’s efforts to compensate for that flawed processing.

Seymour likens the idea to someone kept in solitary



Seymour
discussing areas
in the brain.

confinement or in a dark room for long periods. “People in such situations also perceive things that aren’t there. This is because it is a natural process of the brain to try and make sense of deficient sensory information. There is a truth in the idea that we see what we expect to see.

“Patients with schizophrenia see the world as dimmer and more fragmented in general,” Seymour says. Their hallucinations may result from a tendency to rely more on their beliefs and expectations to interpret the uncertain sensory input.

Our perception of the world is governed by two separate elements of the brain that interact

to enable us to see and process visual information correctly. Seymour describes these elements as the bottom-up system, which is where all the sensory input comes in, and the top-down system, which is about perception — what our previous experience tells us we will see, and the context of that incoming information.

SCHIZOPHRENIA
affects
more than
21
MILLION
PEOPLE
globally



“In schizophrenia the top-down stuff is working overtime to deal with a deficient bottom-up sensory input,” she explains.

One of her collaborators in this research is Philipp Sterzer, professor of psychiatry and computational neuroscience at Charité teaching hospital in Berlin. “We are doing this research because we believe that experiments in visual perception offer an exquisite tool to tap into very basic mechanisms of how people make inferences about the world,” he says. “These basic mechanisms of brain function are relevant not only

for the perceptual anomalies that [schizophrenia] patients have, but they also allow us to make conclusions about more general mechanisms of brain function.”

In addition to MRI, Seymour is using another scanning technique called magnetic resonance spectroscopy, which can show changes in the brain’s neurochemistry, for example, the levels of different neurotransmitters. This could reveal which neurotransmitters play a part in perception, and how they might be altered in individuals with conditions such as schizophrenia.

But Seymour has her eye on even more advanced imaging technology for her research — the next generation of 7 Tesla MRI machines, which provides the strongest magnetic field yet for research applications. This next-generation machine has functional magnetic resonance imaging (fMRI) resolutions 20 times higher than conventional 7 Tesla scanners. Next-generation 7 Tesla scanners aren't currently available in

Australia, but are available at the University of California, Berkeley, and Seymour is working on a collaboration with researchers there to enable her to scan the brains of individuals with schizophrenia and healthy controls, down to the resolution of a poppy seed.

"Being able to look at the brain on that scale, while people are doing particular tasks, is a real advance for human neuroscience," she says.

LEGAL MINDS

While brain imaging can reliably provide insights into how we process sensory information, people are also considering it as a way to provide information about a person's guilt or innocence. But given how little researchers really understand the workings of the brain and mind, it's a fraught proposition. Despite that, neuroscience is already creeping into the courtroom, with lawyers using neurological information about a defendant to argue either for or against culpability.

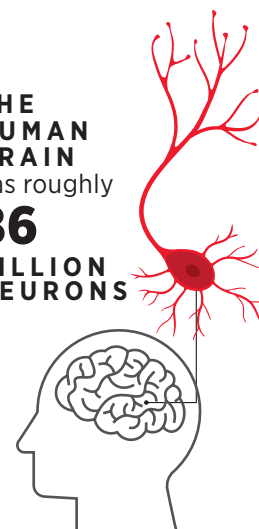
With her interest in brain and behaviour, one case in particular took Seymour's interest. It involved a culpability argument based on the absence of protein plaques in an individual's brain MRI that implied their reasoning couldn't have been compromised by Alzheimer's disease.

It was terrible science that should never have been used in the courtroom, she says, but it is symptomatic of an unquestioning appreciation of any kind of scientific evidence, such as DNA evidence, in the law.

Seymour is looking through legal cases in which neurological evidence has been presented to a courtroom, and what the outcomes of those cases were. To do this, she has been collaborating with legal experts at the University of Sydney, UNSW, and Macquarie University, which maintains a database of so-called 'neurolaw' cases.

"At this stage, it's more about finding out how compatible the decisions and legislation are with what we understand about the brain and behaviour," Seymour says. "The next stage would be to actually educate legal practitioners, which might be the harder part."

THE
HUMAN
BRAIN
has roughly
86
BILLION
NEURONS



"I'm interested in whether the data that is put before a jury or a judge is presented in a way that properly reflects what we understand about the brain and its effects on behaviour — not whether a crime was committed or not," explains Seymour.

For example, while anyone over the age of 18 years is tried as an adult, neuroscientific research suggests that the processes of brain development, including aspects such as impulse control, don't fully taper off until around the age of 25.

There's a strong philosophical dimension to this question: it drives to the heart of issues such as agency, awareness, and culpability, Clifford says. "If I could argue for example that I shouldn't be found guilty because my brain was in a particular state, then it gets back to the question of what is me, what am I responsible for?"

It seems there are not enough hours in the day for Seymour to get around to all the issues and subjects she is interested in.

"I don't want to spread myself too thin," she says. "It would be possibly better to pick just one thing that I'm interested in and focus on that, but I've got interests all over the place." ■



Care is needed in the way neurological evidence is presented in a legal setting.

SDGs: 3

SEARCH FOR A GOLDEN AGE

New evidence that a molecule derived from turmeric could contribute to dementia treatment.

Biochemist, Professor Gerald Münch, has scoured the botanical world for plant extracts with the capacity to snuff out inflammation, a normal immune process that sometimes goes awry in the ageing brain.

His research has unearthed several compounds found in foodstuffs, traditional bush medicines and Australian rainforest plants, all of which help protect brain cells from the fiery immune activation that can destroy neurons, fueling diseases such as Alzheimer's, Parkinson's and traumatic brain injury.

© Cybele Malinowski

NEED TO KNOW

- Curcumin, a component of turmeric, is lauded for its health benefits.
- Western researchers showed curcumin had anti-inflammatory effects in mouse brains.
- Their results are promising for neuroprotection.

One bright yellow molecule stood out from the rest of the pharmacological flora. Curcumin, a component of the Indian curry spice turmeric, offered the most potent suppression of pro-inflammatory immune

cells — in a lab dish, at least. So Münch, with neuroscientist Dr Erika Gyengesi and colleagues from Western Sydney University tested whether the same was true in the brains of living mice.

They turned to a laboratory mouse known as GFAP-IL6. Developed in 1993 by Iain Campbell, a neuroimmunologist now at the University of Sydney, the mouse had been genetically engineered to constantly express an immune-activating molecule called interleukin-6 in the brain.

The resulting inflammation is an extreme version of neurodegeneration, says Campbell, but is useful to understand the mechanisms underlying the process. Even though the GFAP-IL6 mice do not develop the kinds of brain plaques

and tangles that are synonymous with Alzheimer's disease, they do show other aspects of the disease progression, including cerebral atrophy, and rapidly declining motor functions

and cognition as they age. Microglia, immune cells that normally protect the brain from damage, but can also attack neurons when in overdrive, showed proliferation and signs of activation.



Dr Gyengesi examining mouse brain cross sections.

DEMENTIA DOWN UNDER

➤ More than 340,000 Australians have Alzheimer's disease — and without a medical breakthrough, that number is expected to rise to nearly 1 million by mid-century. There is no cure, nothing to prevent the disease, and no way to slow or stop its progression.

This year alone, the disease is predicted to kill some 14,000 Australians and cost society around \$10 billion in healthcare expenditures and another \$5 billion in lost economic productivity. That cost will balloon as the number of cases rise. Yet studies show that even a modest reduction in disease incidence could make a huge impact.

According to a 2017 report prepared for Alzheimer's Australia, a disease advocacy group, a 5% drop in the rate of Alzheimer's among the elderly would lead to a massive \$120 billion savings by 2056.

Initiatives that focus on disease prevention, early intervention and timely diagnosis are critical in the face of the pending Alzheimer's crisis. And in the latest iteration of Australia's Strategic Roadmap for Dementia Research and Translation, the government highlighted the need to pin down how genetics, treatments and environmental exposures all interact to increase or reduce vulnerability to the disease.

AUSTRALIANS WITH ALZHEIMER'S DISEASE



the disease is predicted to kill
**APPROXIMATELY
14,000
PEOPLE**



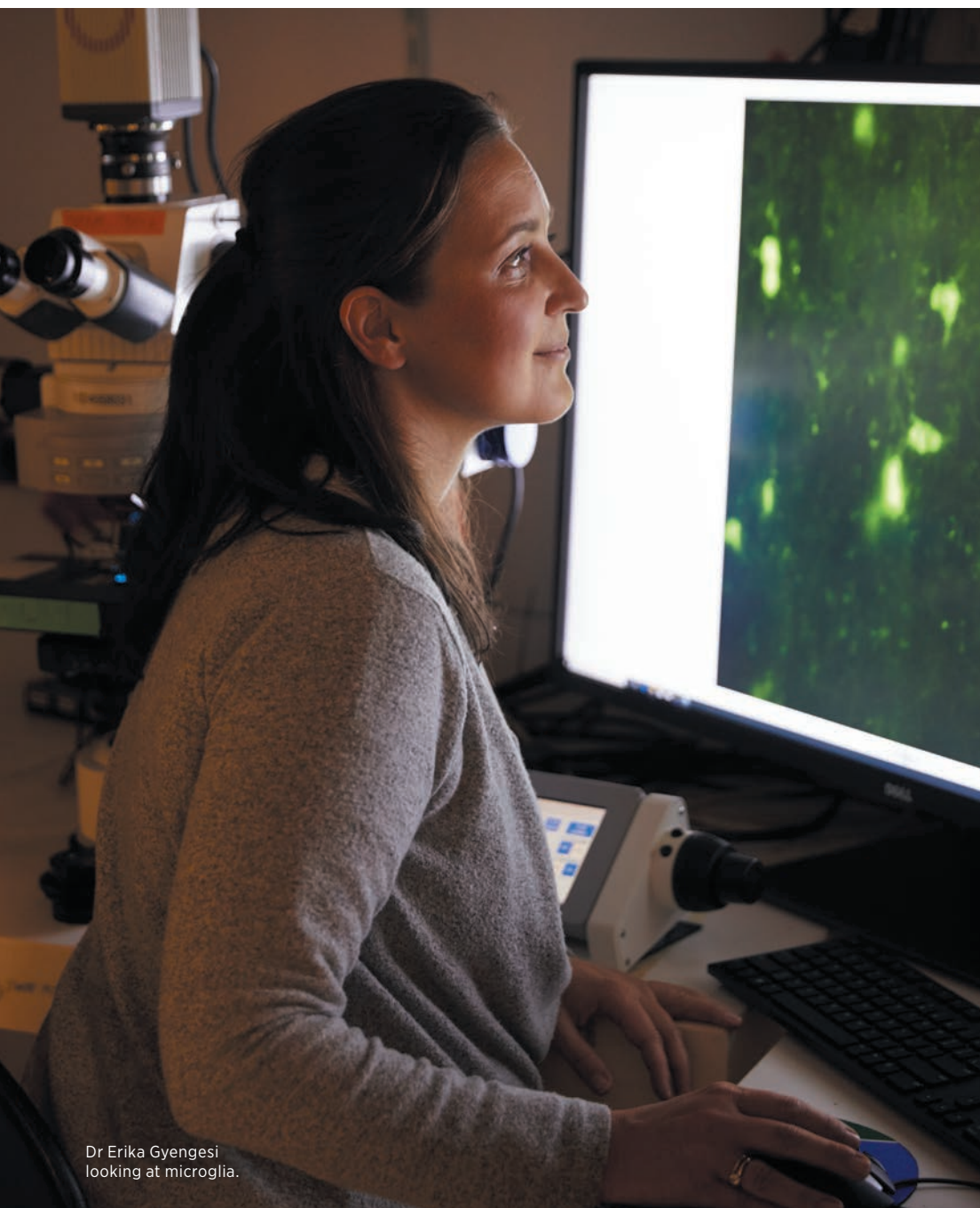
\$10 BILLION
in healthcare
expenditures



\$5 BILLION
in lost economic
productivity



The Münch research group at Western Sydney University's Campbelltown Campus.



Dr Erika Gyengesi
looking at microglia.

As such, says Campbell, “if you can find a drug that interferes with that process at the level of microglial responses, as Gerald is doing, then it’s quite likely that drug may have great translatability into any sort of neuroinflammatory

disease where microglia have a detrimental role.”

Much excitement surrounds the group’s work with curcumin, world-leading investigations that are pioneering the use of natural products for neuroprotection.

HAPPY MICROGLIA

In work slated for publication later in 2019, the team fed GFAP-IL6 mice a version of curcumin formulated to increase the body’s absorption of the anti-inflammatory molecule. After less than

a month on this dietary supplement, they could see dramatic changes in the quality and quantity of microglia in the mouse brains.

“We were surprised that in about four weeks we could reduce the number of active microglia in the GFAP-IL6 mice by about 50%,” says Gyengesi. What’s more, analysis of those cells that were present in the cerebellum and hippocampus — regions of the brain involved in motor control and cognitive processes — showed they were no longer in a hyperactive, pro-inflammatory state after treatment. “We turned angry microglia into happy microglia,” explains Münch.

In another study published in 2018, the team also used the GFAP-IL6 mice to investigate the therapeutic potential of Tenilsetam, a drug once considered a candidate Alzheimer’s remedy by its inventor Hoechst, now part of Sanofi-Aventis, before the research community largely abandoned the molecule in the late 1980s. It similarly showed anti-inflammatory effects in the mice, as evidenced by the decreased number of microglia in the brain. But the gains were more pronounced with curcumin and another plant derivative called apigenin, a compound abundant in parsley. So, the researchers are largely focused on those two natural products.

Now they are conducting behavioural studies to evaluate whether curcumin improved motor function and cognitive performance in the mice as well. In April, Münch’s

research group reported that the GFAP-IL6 mice show an age-dependent deterioration on a variety of behavioural tasks. Now, they are running the same series of tests on the curcumin-fed mice, while also moving to gauge the efficacy of the dietary supplement on other mouse models of neurodegeneration.

For example, Münch, Gyengesi and colleagues have completed experiments in mice that overexpress a precursor to the amyloid protein that clumps to form plaques in Alzheimer's-affected brains. As they showed this year, the curcumin helped lower amyloid deposition somewhat with some behavioural improvements, especially

among mice fed a variety of other food derivatives alongside curcumin.

“CURCUMIN TICKS ALL THE BOXES WHEN IT COMES TO BRAIN HEALTH.”

Gary Small, director of the Longevity Center at the University of California, Los Angeles is a world-leader in neurodegeneration. He is closely watching the team's work. “These biological, mechanistic

studies are quite compelling,” he says.

SUPPLEMENTARY BENEFITS

Last year, Small reported the results of an 18-month, placebo-controlled trial, demonstrating that daily consumption of an easily absorbed curcumin supplement can improve memory and mood among people with mild, age-related memory loss. The study included only 40 participants, and much larger studies are needed to validate the findings, Small says. Still, he is buoyed by the initial suggestion that curcumin may help stave off progression of neurodegeneration and eventually future symptoms of Alzheimer's disease, especially

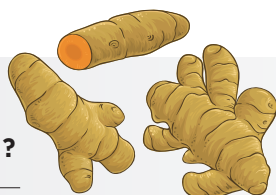
since the molecule is so safe and inexpensive.

“Curcumin ticks all the boxes you're looking for when it comes to brain health,” he says.

Already, most members of Münch's research group are either taking curcumin supplements themselves or giving them to family members who are suffering from inflammatory diseases. “I give it to my mum and dad,” says Gyengesi, who spearheaded most of the mouse studies in Münch's laboratory.

The only holdout not popping curcumin pills is Münch himself. “I hate the taste,” he says. “You burp up the curcumin — and it's all spicy.” ■

THE CURCUMIN CURE?



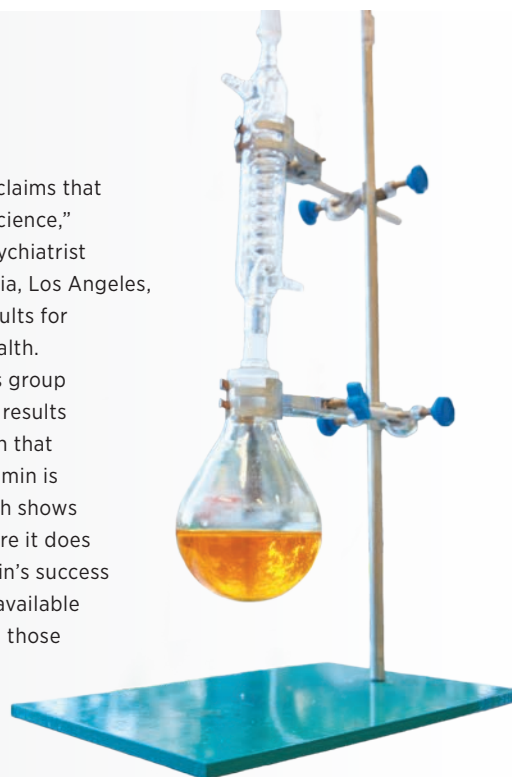
➤ If the hype surrounding turmeric is to be believed, the golden-yellow spice and its active ingredient, curcumin, offer a miracle cure for everything from heart disease and cancer to diabetes and arthritis.

That's a big ask of a dietary supplement — and, in many cases, the marketing seems to have leapt ahead of the evidence.

Some researchers have gone so far as to dismiss curcumin's purported health benefits entirely. A 2017 critical review argued that the molecule acts like a chemical con artist, yielding dubious results in common laboratory assays and leading drug hunters astray. The authors of that paper concluded that, when it comes to curcumin, there's “much ado about nothing”.

“A lot of companies make claims that are not substantiated by the science,” says Gary Small, a geriatric psychiatrist from the University of California, Los Angeles, who has had early positive results for curcumin's effects on brain health.

None of the assays Münch's group has used have yielded unclear results and Small and Münch, maintain that the biological activity of curcumin is real. Says Münch: “Our research shows that it gets into the brain, where it does something. The key to curcumin's success *in vivo* is the use of highly bioavailable curcumin preparations such as those packed into liposomes and nanoparticles.”



SDGs: **3**

CANCER DNA IN THE CROSSHAIRS

By judiciously blocking cancer's ability to repair itself, Western Sydney scientists hope to develop more effective, gentler treatments for the disease.

It may be counterintuitive,

but stopping one of our bodies' repair mechanisms could be the key to successfully treating cancer, according to Western Sydney University's Associate Professor Liza Cubeddu and Dr Roland Gamsjaeger.

Our DNA is constantly under attack — sunlight, even the process of cell replication can damage the genetic code. However, DNA repair molecules inside our cells quickly step in to repair the damage. Cubeddu and Gamsjaeger from Western's School of Science and Health are hoping to exploit these same molecules to help

develop drugs to increase tumour vulnerability.

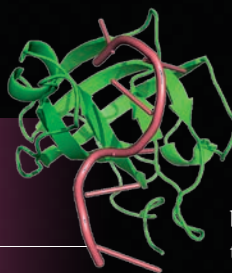
"Cancer cells divide more quickly than normal cells, so they need these DNA repair pathways much more urgently, which lets us target them specifically," explains Gamsjaeger.

"If we can block these DNA repair processes, we could make a cancer cell more sensitive to treatments such as DNA-damaging chemotherapies and radiotherapy," adds Cubeddu.

"This would mean doctors wouldn't need to administer these treatments for so long or at such high doses, which we're hoping will limit the side-effects."

NEED TO KNOW

- DNA repair molecules fix cellular damage.
- Blocking these molecules could make cancer cells more sensitive to treatment.
- Researchers are developing drugs to block hSSB1, one of these repair molecules.



of hSSB1, allowing them to see the molecule's weak spots better than ever before. The team have partnered with CARP Pharmaceuticals, which is developing cancer drugs to block hSSB1, based on the molecule's 3D snapshot.

"When we needed to find collaborators to solve a structural problem, Associate Professor Cubeddu and Dr Gamsjaeger were the obvious choice. Their research has helped drive our cancer drug development programme forward," says Professor Derek Richard from the Queensland University of Technology, who co-founded CARP Pharmaceuticals.

With DNA repair drugs already on the market, the scientists have high confidence their approach will lead to another therapy which, if used in combination with existing approaches, will help make treatments for cancer patients gentler and more effective. ■

In 2008, the team discovered a DNA repair protein molecule called hSSB1 and over the course of 10 years, homed in on the molecule's 'weak spots', which if targeted with a drug, could render it unable to repair DNA in cancer cells.

In 2018, Cubeddu and Gamsjaeger used nuclear magnetic resonance (NMR) spectroscopy to take a molecular snapshot of the 3D structure

Cancer cells need DNA pathways to repair themselves.



MEET OUR DISTINGUISHED PROFESSORS



PROFESSOR

Wei Xing Zheng

School of Computing, Engineering and Mathematics

"I enjoy tackling interesting and challenging questions – it gives you a real sense of achievement," says Distinguished Professor Wei Xing Zheng. Zheng's research on control theory and signal processing has attracted national and international esteem. He has been identified as a Clarivate Analytics Highly Cited Researcher for the past four years.

"Control theory is sometimes called 'enabling technology'. We develop a theory/technology which can be applied in areas such as electrical and mechanical engineering, communications, and even artificial intelligence," he explains.

Zheng completed his PhD in Electrical Engineering at Southeast University, Nanjing, China, where he held an academic appointment until 1991. From 1991 he held a number of international positions before joining WSU in 1994. He was named a fellow of the Institute of Electrical and Electronics Engineers in 2014, and WSU's Researcher of the Year for 2017. "Western is a wonderful place. If you work hard, your achievements will be recognised by the University. I feel very gratified."



PROFESSOR

Annemarie Hennessy, AM

School of Medicine

"Wow! Who would have ever thought the publican's daughter could do or be this," was Annemarie Hennessy's reaction to being named, in 2018, as one of Western's Distinguished Professors.

As Dean and Foundation Chair of Medicine, Hennessy has focused her research on preeclampsia and maternal and prenatal health. "The causes and treatments for preeclampsia, the most common complication of pregnancy, are within sight. Our work has contributed to a real depth of understanding about how this disease happens," she explains.

Distinguished Professor Hennessy, who trained as an obstetric and renal physician, was inducted as a Member of the Order of Australia in 2015 for her significant service to tertiary education and medical research. She was also made an honorary fellow of The Royal Australian and New Zealand College of Obstetricians and Gynaecologists in 2018.

"I love the variety of the work: one minute with women and their babies, the next with the students and research team, and the next with colleagues building a research life."

Hennessy is also the Managing Director of PEARLS, a non-profit organisation based at the Heart Research Institute, that raises funds to support ongoing research into the cause of preeclampsia in pregnancy.

**PROFESSOR**

Ien Ang

Institute for Culture and Society

"I enjoy being creative in research and pursuing my curiosity about the complexities of contemporary culture and society; the intricacies of how multicultural societies work in a globalised world. There are so many different stories to tell about people from varied backgrounds and life trajectories," says Distinguished Professor Ien Ang, a global leader in cultural studies.

Ang developed an ethnographic approach to audience research which attracted worldwide attention and paved the way for what was later called the 'active audience approach'. "My research provides in-depth understanding that goes beyond lifeless data and statistics, insights that resonate with people," she explains.

Ang, who was the founding Director of the Institute for Culture and Society, joined WSU in 1996, where she has since worked collaboratively with a diverse range of organisations including the NSW Migration Heritage Centre, the Art Gallery of New South Wales, the Special Broadcasting Service (SBS), the Museum of Contemporary Art, the City of Sydney, the Australia Council and the Australian Academy of the Humanities.

**PROFESSOR**

Anne Cutler

The MARCS Institute for Brain, Behaviour and Development

Since completing her PhD at the University of Texas in the 1970s in the comparatively new field of psycholinguistics, the study of the interactions between linguistic and psychological processes — Distinguished Professor Anne Cutler has tackled many of the major puzzles about the ways listeners decode speech.

"My colleagues and I showed that listeners with different native languages hearing the same speech input were using different processing procedures to interpret it," she explains. Since then, Cutler has focussed her research on understanding how the processes of decoding speech in the brain are shaped by language-specific listening experience.

Cutler joined the MARCS Institute in 2013, and is also an Emeritus Director at the Max Planck Institute for Psycholinguistics in the Netherlands.

**PROFESSOR**

David Tissue

Hawkesbury Institute for the Environment

"It would be hard to find a better job," says Distinguished Professor David Tissue on his research, mentoring and teaching. An internationally renowned expert, Tissue's work helps determine the impact of climate factors on agriculture and natural ecosystems.

"It has been very rewarding to be at the forefront of climate change science and see that this work has been valuable to scientists and citizens alike."

He hopes that his role as a Distinguished Professor will provide a platform for discussions with industry and the public about the importance of incorporating climate change into their businesses and lifestyles. "It is often an uphill battle, but one worth pursuing given its importance to everyone," he says.

**PROFESSOR****David Simmons***School of Medicine*

Distinguished Professor David Simmons is internationally recognised for his work in diabetes epidemiology, diabetes in pregnancy and diabetes service development. He is also the Head of the Campbelltown Hospital Endocrinology Department.

Simmons' work has influenced health policy and community guidelines and, ultimately, saved or improved lives. He joined WSU in 2015, after working in institutes across Australia, the UK, New Zealand and the USA.

"It's wonderful to be appreciated by the University and my peers in this way. Hopefully it will help increase awareness of the diabetes epidemic and attract young researchers into this line of work," he says.

**PROFESSOR****Lynn Kemp***School of Nursing and Midwifery*

Western's Researcher of the Year for 2018, Distinguished Professor Lynn Kemp is an international leader in the field of early childhood interventions in primary and community health and translational research. Through the Maternal Early Childhood Sustained Home-visiting (MECSH) program she developed in south-west Sydney, Kemp's work has touched the lives of more than 15,000 families across the world.

"Seeing the difference MECSH makes for children and families, and the increased satisfaction of the nurses who work with them, brings me personal and professional enjoyment," says Kemp.

Kemp joined the University in 2015 as the Director of the School of Nursing and Midwifery's Translational Research and Social Innovation team.

**PROFESSOR****Andre Renzaho***School of Social Sciences and Psychology*

Distinguished Professor Andre Renzaho's mission is to confront health inequities from an international, multidisciplinary perspective. With more than 20 years' experience in humanitarian and development aid, Distinguished Professor Renzaho's research has led to policy changes at the country and NGO levels that have helped improve health service delivery and population health outcomes for those marginalised by poverty, conflict, famine and disease.

He joined Western in 2015 and, in 2018, was ranked 3rd in Australia and 10th in the world as a leading researcher in Global Migration Health. He is also a lead researcher for the World Health Organization project on the Global Burden of Disease and regularly consults for governments, NGOs and international agencies.

"What is satisfying about my work is contributing to the production of knowledge as a social good and providing solutions to the world's toughest health problems," Renzaho says.

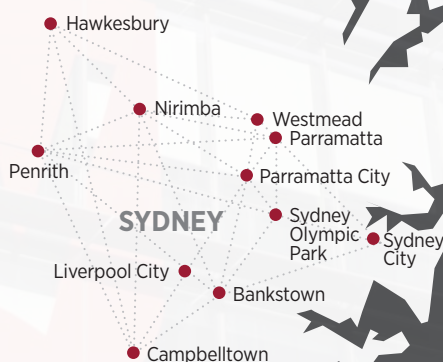


CAMPUS MAP

Ho Chi Minh City

CAMPUS MAP

AUSTRALIA NEW SOUTH WALES



CENTRES OF DISCOVERY

Western Sydney University campuses are situated in regional and CBD locations throughout Greater Western Sydney.

Further information can be found here:
[westernsydney.edu.au/future/
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ABOUT

Western Sydney University is a large, student-centred,
research-led university, embracing Australia's global
city, Sydney. Established in 1989, the University proudly
traces its history to 1891 through the Hawkesbury
Agricultural College. Today the University has more than
180,000 alumni, 45,000 students and 3,300 staff.

The University is now ranked in all major global
university ranking systems, and is in the top 2% of
universities worldwide. Through investment in its
academic strengths and facilities, the University continues
to build its profile as a research leader in Australia and is
nurturing the next generation of researchers.

Western Sydney University graduates go on to
take up rewarding careers that make real contributions
to societal change, lifting the pride of students, staff and
the community.

A guiding principle for the University is that there is
no limit to potential success for those with drive, talent,
confidence and ambition.
westernsydney.edu.au



WESTERN'S CHAMPION SOLAR CAR TEAM TO COMPETE IN THE 2019 BRIDGESTONE WORLD SOLAR CHALLENGE

In 2018, Western Sydney University's solar car team became the first Australian and only international team to win the American Solar Challenge, a gruelling 2,800km race which sees international university competitors travel across four US states from Nebraska to Oregon. This October, the team will compete in the Bridgestone World Solar Challenge, a 3,000km race from Darwin to Adelaide.



Photo credit: Sally Tsoutas. Western's latest solar car: UNLIMITED 3.0

A student-led project incorporating the latest in aerodynamic and solar technology research, the team is comprised of students from the fields of Engineering, ICT, Industrial Design, and Visual Communications, supported by the School of Computing, Engineering and Mathematics.

Follow the team as they prepare for this epic challenge: facebook.com/WestSydSolarTeam

Learn more about solar car research at Western Sydney
westernsydney.edu.au/solarcar

ABILITY LEARNING VISION MEMORY ADVANCED
PERCEPTION INTELLIGENCE PHYSIOLOG MOTION
ADVANCED CONSCIOUSNESS SENSORY VISION
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